GEMINI SPACECRAFT

NASA-MCDONNELL

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The next major step in U. S. manned space exploration is Project Gemini . . . the program undertaken by the National Aeronautics and Space Administration. The prime contract for the spacecraft in this effort was awarded to McDonnell Aircraft Corporation, St. Louis, Missouri.

The objectives of Gemini are to provide an early means of experimenting with long duration earth-orbital manned flights up to two weeks to determine man's performance capabilities under prolonged periods of weightlessness, and to carry out scientific investigations of space that require men to participate and supervise; to demonstrate rendezvous and docking with a target vehicle in earth orbit as an operational technique; and, to demonstrate controlled re-entry and land landing at a pre-selected point.

EXTENDED MANNED ORBITAL FLIGHTS

A U. S. Air Force modified Titan II booster launches the two-man spacecraft into a near earth elliptical orbit.

Launch During the launch phase the astronauts monitor instruments and displays including special instrumentation that senses launch vehicle conditions. At staging the second stage booster engine is lit-off and the first stage separates. Launch vehicle first stage separation is sensed and displayed to the spacecraft crew. When the booster's second stage cutoff is sensed and displayed to the Gemini crew, the spacecraft is disconnected from the launch vehicle by firing explosive charges. Spacecraft maneuvering rockets are used to achieve positive separation.

Orbit When Gemini reaches the apogee (highest point) of its elliptical orbit, thrust from the maneuvering system is used to push the spacecraft into a nearly circular orbit. While in the orbital phase of the mission the environmental control system maintains the cabin and suit circuit pressure, temperature and ventilation settings. Instrumentation equipment permits sampling and storing of data. The attitude control system is used to properly orient the spacecraft. The crew monitors the spacecraft systems and performs tasks appropriate to the mission.

Retrograde After the orbital phase of the mission is completed, explosive charges are fired which jettison the equipment section of the adapter module. Descent from orbit is then initiated by the application of retro-thrust rockets on the spacecraft.

Re-entry When the retro-thrust rockets are expended, the retrograde section of the adapter module is jettisoned and the re-entry module is commanded to assume a re-entry attitude. A reaction control system is used to maintain re-entry module attitudes.

Landing At about 60,000 feet, the landing sequence is initiated. A paraglider deploys and enables the astronauts to maneuver the re-entry module to a pre-selected landing site. An extendable skid-type landing gear provides for a safe landing. The spacecraft touches the earth with a forward velocity of about 45 miles per hour.

RENDEZVOUS AND DOCKING FLIGHTS

A version of the Agena, similar to that used in Ranger and Discoverer projects, will be used as the orbiting target satellite. Its forward section will be the McDonnell-designed docking adapter. This incorporates the mechanisms which lock the Gemini and Agena during docking, and connect the Gemini command systems to the Agena, enabling the astronauts to control the composite vehicle through the Agena's rocket motors.

Launch An Atlas booster launches the Agena target vehicle into a nearly circular orbit at approximately the same altitude as the spacecraft orbit. After ground tracking stations determine the optimum launch time, Gemini is inserted into an elliptical orbit at an altitude lower than that of the target. At the apogee of the ellipse, Gemini reaches the same altitude as the target.

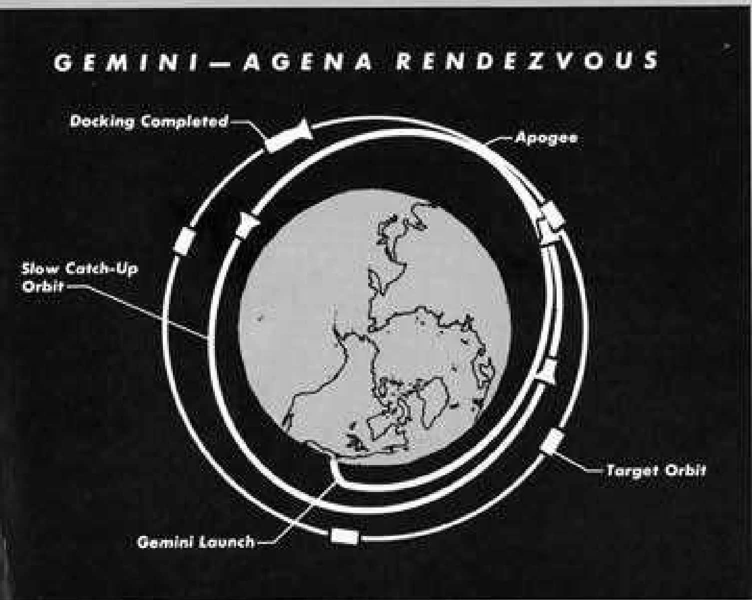
Catch-Up Since the orbital period (time to complete one orbit) of Gemini is less than that of the Agena because of its lower altitude, it will circle the earth more quickly, and gradually catch up.

Rendezvous When radar contact is made, a terminal guidance phase is initiated and Gemini is maneuvered to bring the two paths together. In the absence of radar data, rendezvous may be accomplished by instructions and commands from the ground tracking and computer stations relayed to the spacecraft and target vehicle. When the two crafts are within 20 miles of each other, final maneuvers and docking would be controlled by the astronauts using visual observations.

Docking When Gemini is within a few hundred feet of the target, relative velocities have been reduced to very

small values. Visual observation of the target is utilized to provide steering information for the final docking maneuver. Spacecraft attitude is controlled for compatibility with the docking mechanism.

Mooring The vehicles make contact at a very low relative speed and are latched together. Once latched, the Gemini-Agena combination may be controlled and maneuvered as a single unit. When evaluation of this phase is completed, the vehicles are unlatched and separation is achieved by firing the Gemini maneuvering thrust rockets.



Retrograde Retrograde, re-entry and landing operations are the same as described for extended manned orbital flights.

LIFE SUPPORT SYSTEM

The crew compartment has provisions for seating two crew members in a side-by-side seating arrangement. Each seat provides arm rests and foot supports in addition to a restraint system for support against maximum acceleration forces. Pressure, temperature and composition of atmosphere in the spacecraft are maintained within allowable limits for human environment. Food and water are provided for the mission and a 48-hour post-landing period.

Each astronaut wears a pressure suit that includes provisions for natural body processes. The headgear incorporates a microphone and earphones. Air enters the suit and is routed through lines directly to the face area, the arms and legs. The air is allowed to return next to the astronaut's skin and out the exhaust line. The suit has a metallic finish that acts as an additional heat buffer.

During advanced stages of the Gemini program, the crew may open the hatches and climb out of the spacecraft while in orbit. This will require development of an "extra-vehicular" suit. The spacecraft contains sufficient oxygen to re-pressurize the cabin after these exercises are completed.

GUIDANCE AND CONTROLS

Horizon Sensors Horizon sensors, of the infrared-detecting type, sense spacecraft roll and pitch attitudes with respect to the earth's horizon. These sensors provide the basis for attitude reference throughout the mission.

Attitude Controls An attitude control system, consisting of attitude sensors, is incorporated in the spacecraft. It provides for manual and automatic control of stabilization and orientation of the spacecraft attitude, responding to guidance system and astronaut commands, depending on the mode of operation established.

Inertial Guidance An inertial guidance system aboard the spacecraft serves both as an attitude reference and as a means of navigation during rendezvous, re-entry, and paraglider landing. The system comprises a space-stabilized platform (which carries instruments to measure the accelerations applied to the spacecraft) operating in conjunction with a general purpose digital computer.

Rendezvous Radar A single rendezvous radar provides range, range rate and line of sight angle to the target. Range and range rate information are provided to a minimum range of less than 20 feet from the target.

PROPULSION

Retrograde System The retrograde rocket system provides the means of slowing the re-entry module to permit re-entry into the earth's atmosphere. Solid propellant rockets fire in ripple fashion upon a signal, by the crew, or by an automatic device within the spacecraft, which is armed by the crew. The retrograde system may

also be utilized to separate the re-entry module from the launch vehicle in the event of a mission abort during launch.

Orbit Attitude and Maneuvering System Composed of a series of small rocket engines located in several positions about the spacecraft, this system provides the means for controlling the spacecraft about its three major axes and for maneuvering it up and down, fore and aft and sideways. The combination of attitude control and maneuvering capability provides the means for rendezvous and docking with the target vehicle, as well as stabilization while orbiting.

Reaction Controls Two completely independent reaction control systems are mounted on the re-entry module. The systems are utilized simultaneously for attaining retro attitude and then for maintaining re-entry module attitudes about the three major axes after separation of the adapter module equipment section. In the event of a failure in either system the other is capable of satisfactorily completing the mission. The system receives operating commands from either the astronaut's hand controller or the attitude control system electronics.

ELECTRICAL SYSTEM

The spacecraft electrical system utilizes fuel cells. The fuel cell produces electricity through the chemical reaction of oxygen and hydrogen. Two separate fuel cells are located in the equipment section of the adapter module. Gemini is the first space vehicle to use fuel cells as a primary electrical power source. In addition to lighter weight as compared with other types of available power sources, the fuel cell produces a pint of pure drinkable water as a by-product of each kilowatt hour of operation.

Since the adapter module is jettisoned prior to re-entry, an array of silver zinc batteries is provided in the re-entry module to provide power for the re-entry, landing, and post-landing phases of the mission. These batteries also serve as an emergency power source in orbit.

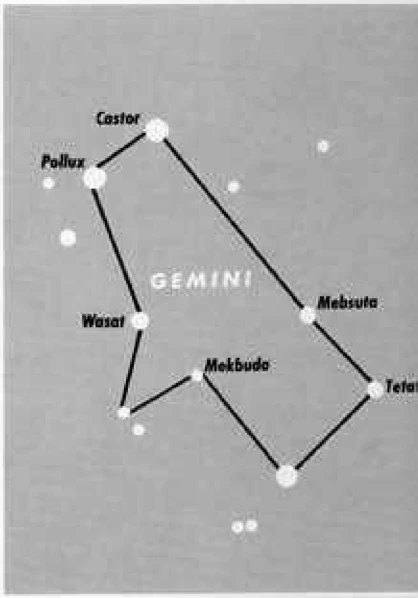
COMMUNICATION

The crew has voice communication with the ground stations for a portion of each 90-minute orbit of the earth. Equipment includes two-way HF and UHF radios, receivers for command from the ground, telemetry equipment for transmission of data from spacecraft to ground stations, radio tracking beacons, and a means for communication between the spacecraft and the target vehicle.

INSTRUMENTATION AND RECORDING

The instrumentation and recording system provides the means for collecting, transmitting and/or recording data generated in the spacecraft. Equipment is included to evaluate the crew's reaction to space flight, to measure and monitor internal and external spacecraft environment, to record and transmit to the ground all data pertaining to scientific observations and rendezvous and docking operations.

In the language of astronomers, Gemini is the third zodiacal constellation, pictorially represented as the Twins, Castor and Pollux, sitting together, with the two bright stars named after them marking the position of their heads. It is in the Milky Way galaxy.



LANDING AND RECOVERY

At a preset altitude of about 60,000 feet a drogue parachute is deployed. The parachute removes a paraglider-radar housing and deploys a paraglider. The paraglider, including the reels, cables and inflation system is deployed in a restrained condition to allow inflation prior to transferring loads to the steering mechanism. The paraglider is fully inflated at 40,000 feet and provides a controlled glide range of about 20 miles. A three-skid extendable landing gear is also provided. The nose skid extends when the paraglider is deployed. Main skid extension is initiated by the crew subsequent to paraglider deployment. Post-landing recovery aids include tracking beacons, high-intensity flashing light system and two-way voice radios.

LAUNCHING SEQUENCE

1. Atlas booster lifts Agena (target vehicle) from launching pad.

2. Agena is placed in a circular orbit.

3. Titan booster lifts two-man Gemini spacecraft from launching pad.

4. Gemini and Titan II continue to climb.

5. 2nd Stage Booster and Gemini Separate from Burned Out 1st Stage.

6. Gemini is inserted into an elliptical orbit.

7. Using maneuvering rockets, Gemini closes on target.

8. Vehicles make contact (at nearly identical orbital velocities) and are latched together.

9. Composite vehicle is maneuvered as a single unit.

10. After unlatching, Gemini equipment section is jettisoned.

11. Retrograde rockets are fired to decrease speed for reentry.

12. Paraglider deployment is complete at 40,000 feet.

13. Astronauts maneuver spacecraft to a pre-selected landing site.

PROJECT GEMINI

The spacecraft is made up of two major sections—the re-entry module and the adapter module. The re-entry module is the portion that houses the crew throughout the flight. It weighs approximately twice as much as its predecessor, Mercury, and is about 20 percent larger with about 50 percent more volume. The cabin incorporates an ejection seat for each crew member as a means of emergency escape from the spacecraft. The adapter module, which is jettisoned prior to re-entry, supports the re-entry module on the launch vehicle and includes an equipment section that contains the main oxygen supply, primary electrical power system, a propulsion system for orbital attitude control and maneuvers; and, a separate section which contains a retrograde system.

The design criteria for Gemini is to provide an operational spacecraft that is easily maintained. Most of the equipment aboard Gemini will be self-contained and placed outside the crew space. Major components will be arranged in easily removed, replaceable shelves, thereby reducing maintenance and checkout time.